Patent Claims

1. Transmission spectrometer with a sensor to which, through at least one optical waveguide for emitted radiation, the radiation of at least one radiation source can be introduced, in order to direct it on and/or in an object to be investigated, and with at least one optical waveguide for detected radiation at a distance from the sensor, through which radiation, which was scattered by, transmitted by and/or emitted by the object to be investigated, especially fluorescent radiation, can be introduced to and/or on a radiation detector, which can be connected to an evaluation unit, where
a number of radiation sources are provided, the radiation intensities of each one of which can be adjusted, and which have an emission spectrum which is broadband either per radiation source or for all radiation sources together, and each of which is are coupled directly to an optical waveguide for emitted radiation,
the radiation detector detects the entire spectrum of the radiation which is entered in the optical waveguide for detected radiation by diffuse and/or directional reflection, transmission, emission and/or fluorescence, and
in the evaluation unit, as a function of at least one program which can be selected through an operating unit for the calculation of at least one parameter, at least the intensity of one given wavelength can be processed.

2. Reflection spectrometer with a sensor to which, through at least one optical waveguide for emitted radiation, the radiation of at least one radiation source can be introduced, in order to direct it on and/or in an object to be investigated, and through which, with at least one optical waveguide for detected radiation, radiation, which was scattered by, transmitted by and/or emitted by the object to be investigated, by especially fluorescent radiation, can be introduced to a radiation detector, which can be connected to an evaluation unit, characterized by the fact that
a number of radiation sources (10-15) are provided, the radiation intensities of each one of which can be adjusted, and which have an emission spectrum which is broadband either per radiation source (10-15) or for all radiation sources (10-15) together, and each of

which is coupled directly to an optical waveguide for emitted radiation (20-25),
the radiation detector (30) detects the entire spectrum of the radiation which is entered in the optical waveguide for detected radiation (40) by diffuse and/or directional reflection and/or fluorescence, and
in the evaluation unit (50), as a function of at least one program which can be selected through an operating unit for the calculation of at least one parameter, at least the intensity of one given wavelength can be processed.

3. Spectrometer according to Claim 2, including furthermore at least one optical waveguide for detected radiation at a distance from the sensor, through which radiation scattered in, transmitted by and/or emitted by the object to be investigated, especially fluorescent radiation, can be introduced through a radiation detector which can be connected to an evaluation unit.

4. Spectrometer according to Claim 1 or 3, characterized by the fact that the radiation incident axis of at least a first distanced optical waveguide for detected radiation lies essentially on the line of the radiation exit axis of an optical waveguide for emitted radiation and/or it is arranged essentially parallel to this, or that the radiation incident axis of a second distanced optical waveguide for detected radiation at a distance is arranged in an angle not equal to 0°, 180°or 360°, especially 45°, 90°, 270° or 315° to the radiation exit axis of the optical fiber for emitted light.

5. Spectrometer according to one of the previous claims, characterized by the fact that the radiation sources are cold light sources and/or semiconductors, preferably in the form of LEDs (10 – 15) or lasers.

6. Spectrometer according to one of the previous claims, characterized by the fact that the radiation sources (10 – 15) are all emitting equally and in a broad band or at least partly differently . and are emitting in a specified spectral region.

7. Spectrometer according to one of the previous claims, characterized by the fact that at least two radiation sources are emitting in different or not completely overlapping spectral regions, especially with different intensities.

8. Spectrometer according to Claim 6 or 7, characterized by the fact that the radiation sources include at least one radiation source (10, 13) for emitting red light, at least one radiation source (11, 14) for emitting blue light and at least one radiation source (12, 15) for emitting green light.

9. Spectrometer according to one of the previous claims, characterized by the fact that on each radiation source (10 – 15) an optical waveguide for emitted radiation (20 – 25), preferably in the form of an optical fiber, especially a glass optical fiber is applied with an optically transparent adhesive.

10. Spectrometer according to Claim 9, characterized by screening of the optical waveguide for emitted radiation at least in the region of the adhesive on the radiation source to prevent coupling-in of stray light.

11. Spectrometer according Claim 9 or 10, characterized by the fact that the housing of the radiation source, the adhesive and the optical waveguide for emitted radiation have essentially the same refractive index, at least in the region of the adhesive.

12. Spectrometer according to one of the previous claims, characterized by the fact that the optical waveguide for detected radiation (40), preferably in the form of an optical fiber, especially a glass optical fiber can be attached, especially clamped, into an inlet gap of the radiation detector 30.

13. Spectrometer according to one Claims 2 to 12, characterized by the fact that in the sensor (2), preferably at the free end of the sensor (2), the radiation coupling-in end (40a) of the optical waveguide for detected radiation (40) is surrounded by the radiation coupling-out ends (20b-25b) of the optical waveguide for emitted radiation (20-25), preferably essentially circularly, in such a way that in the

measuring range on and/or in the object to be investigated there is at least a partial overlap of the aperture of the optical waveguide for detected radiation (40) with the aperture of the optical waveguide for emitted radiation (20-25).

14. Spectrometer according to one of the previous claims, characterized by the fact that the radiation detector includes an optical multi-channel detector, especially a CCD detector (3) or a diode array.

15. Spectrometer according to one of the previous claims, characterized by the fact that in the evaluation unit a number of individual spectra can be deposited in a time sequence, especially can be stored, and can be analyzed, especially with consideration of their time sequence.

16. Spectrometer according to Claim 15, characterized by the fact that at least two, especially all, individual spectra can be received at intervals in the range of microseconds to seconds.

17. Spectrometer according to one of the previous claims, characterized by the fact that in the evaluation unit (50) signals from the radiation detector (30) can be resolved into a timewise constant and timewise changeable, especially pulsating, component for separate evaluation.

18. Spectrometer according to one of the previous claims, characterized by the fact that in the evaluation unit (50) programs are stored for food control, for the determination of oxygen saturation and/or hemoglobin concentration in tissue, for the control of the color, reflection and/or gloss properties of surfaces, dyes and/or paints, for medical analysis, for process analysis and/or for environmental analysis.

19. Spectrometer according to one of the previous claims, characterized by the fact that the evaluation unit is in working connection with the radiation sources in such a way that, as a function of the selected program, the intensity of the radiation

emitted by each radiation source can be adjusted individually, especially through the current introduced to the radiation sources.

20. Spectrometer according to one of the previous claims, characterized by the fact that the sensor is surrounded by an endoscope, the sensor (2) has a housing separate from the radiation sources and the radiation detector and/or the sensor (2) can be handheld.

21. Spectrometer according to one of the previous claims, characterized by a display unit in working connection with the evaluation unit for displaying a certain parameter.

22. Spectrometer according to one of the previous claims, characterized by the fact that the working connection between the radiation detector and the evaluation unit, between the evaluation and the operating unit, between the evaluation unit and the display unit and/or between the evaluation unit and the radiation sources is done telemetrically and/or by radio, infrared radiation or through the internet.

23. Spectrometer according to one of the previous claims, characterized by the fact that at least one radiation source can be switched at least for one time period of a measurement in pulsed operation or can be operated with a multiplex pattern.

24. Spectrometer according to Claim 23, characterized by the fact that at least two radiation sources in pulsed operation can be switched or each can be operated with an individual multiplex pattern, where at least two radiation sources are emitting in different or in only partially overlapping spectral regions.

25. Utilization of a transmission spectrometer according to Claim 1, as well as according to Subclaims 2 – 24, as long as these are referring back to Claim 1, for the measurement of the color, turbidity of liquids and/or of the size distribution of particles suspended in fluids, especially in environmental and water analysis or in alcoholic or nonalcoholic beverages.

26. Application of the reflection spectrometer according to Claims 2 to 24 for the detection of the amount of carotenes or dyes in foods or for color control of textiles, cosmetics, adjustments of toupees or for environmental analysis.